REMARKS

By the present amendment, claims 7 and 8 are pending in the application.

Support For Claims

The arrangement of the rolling mill in independent method claim 7 and independent apparatus claim 8 is illustrated in Fig. 4 of the drawings.

With reference to page 13, lines 28-32 of the specification, Fr^W and Fr^D are rolling direction forces acting on the work rolls at the right side or operator side and the left side or driving side, respectively. With reference to the specification at page 1, lines 21-25, the operator side is the right side and the driving side is the left side.

Fr^W and Fr^D are determined on the basis of the measured value of the load "q" for each segment of the split backup rolls. See, e.g., specification, page 13, lines 16-32.

Fr^{df} is the left-right balance of the rolling direction force acting between the rolled material and the work rolls. $Fr^{df} = Fr^W - Fr^D$. See, e.g., specification, page 14, lines 1 to 7.

With reference to the specification, e.g., page 14, lines 8-23, there is a controlling of the left-right difference of the roll gap between the upper work roll and the lower work roll to result in the calculating difference Fr^{df} approaching zero.

In amended independent claims 7 and 8, the new claim limitation --through the rolled material using imaginary rolling direction force $F_R{}^W$ and $F_R{}^D$ acting between the rolled material and the work roll evaluated at the work roll chock position on the operator side and the driving side-- is supported in the specification, e.g., at page 13, lines 28 to 32.

In amended independent claims 7 and 8, the formula for $F_R{}^W - F_R{}^D$ is disclosed in the specification at page 13, line 18.

In amended independent claims 7 and 8, the definitions for q_i, θ_i, Z_i and a_W are disclosed in the specification, e.g., at page 13, lines 19 to 27.

In amended independent claims 7 and 8, the definition for F^W and F^D are disclosed in the specification, e.g., at page 13, line 33 to page 14, line 1.

§103

Claims 7 and 8 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 06-262207 to Ogawa et al. in view of U.S. Patent No. 3,587,263 to McCarthy.

This rejection, as applied to amended claims 7 and 8, is respectfully traversed.

Present Invention

The present invention provides a rolling method and a rolling apparatus for a flat-rolled metal material.

According to the present invention, in order to reduce camber, the roll gap is controlled based on the left-right difference of rolling direction force so that left-right difference of rolling direction force approaches zero.

Further, the present invention has a technical feature that the left-right difference of rolling direction force F_R^{Df} is calculated by using an imaginary rolling direction force F_R^W , F_R^D based on formula <2> at page 13, line 18 of the specification and a measured load value of backup roll load.

$$F_R^W - F_R^D = (2/a_w)\,\Sigma Z_i q_i \cos\theta_i - (F^W - F^D) \qquad \ldots\ldots <2>$$

Since, in the method of the present invention, the roll gap is controlled based on the calculated difference of rolling direction force using imaginary rolling direction force generated by camber that has occurred, control is not influenced by disturbances such as asymmetry of the sheet thickness of the rolled material, temperature distribution and

deformation resistance distribution in the width direction of the rolled material and camber control with high accuracy can be obtained.

Patentability

Japan No. 06-262207 ("JP ' 207")

JP '207 relates to a tandem mill excellent in controllability of crown and shape of the rolled material and discloses a tandem mill characterized by arranging, as a last stand, a finishing mill in which either one or both of roll assemblies have a construction wherein work rolls are supported by split backup rolls split into at least three segments in an axial direction and each segment of the split backup rolls independently has a load measuring device and a rolling reduction device.

However, in JP '207, in order to maintain the shape of the plate constant, which changes due to disturbances such as plate-crown (profile), deformation resistance and others, load distribution of the split backup rolls is controlled so as to make load distribution between the plate and work rolls uniform.

Therefore, in JP '207, in order to prevent camber, the left and right balance of rolling direction force acting between the rolled material and the work rolls is not controlled based on the imaginary rolling direction force, namely rolling direction force evaluated at the work roll chock position on the operator side and driving side.

In other words. JP '207 lacks calculation/control functions calculating the left and right balance of rolling direction force and controlling the left-right swiveling component of the rolling direction force to zero.

Therefore, JP '207 does not disclose or suggest the present invention.

U.S. Patent No. 3,587,263 ("US ' 263")

US '263 relates to a method and a apparatus for steering strip material through a rolling mill, particularly when the mill is threaded in a manner to prevent the strip from turning off the center line of the mill due to camber. US ' 263 discloses a method of detecting unevenness of rolling reduction in the width direction of a plate by load cells arranged on the operator side and driving side during rolling a strip and controlling the gap of rolls of the mill so as to solve unevenness (unbalance) of the rolling reduction.

Thus, according to US '263, the roll gap is controlled based on the balance of vertical direction load.

On the other hand, in the present invention, the roll gap is controlled based on the balance in the rolling direction not on the balance in the vertical direction.

Therefore the present invention is completely different from US '263.

Deficiencies in JP '207 and US '263

According to the method or apparatus of JP '207 and US '263, there may be cases where camber control cannot be performed.

For example, in the case where the plate has a uniform plate thickness but has a distribution in deformation resistance in the width direction, e.g., hard on the operator side and soft on the driving side, in order to prevent camber, roll gap has to be controlled so that the rolling reduction ratio is made even.

At that time, under the above assumption of the plate, load on the operator side becomes inevitably larger than that on the driving side.

However, according to JP '209 and US '263, the system erroneously acknowledges that such phenomenon (unevenness of load) occurs due to the rolling reduction

on the operator side being larger than that on the driving side, and the roll gap on the operator side is controlled to be raised.

As a result, camber which originally has not occurred is newly occurring.

On the other hand, according to the present invention, since the roll gap is controlled by calculating the imaginary rolling direction force generated by the camber, such errors do not occur.

It is therefore submitted that amended independent claims 7 and 8 are patentable over Japan No. 06-262207 in view of U.S. Patent No. 3,587,263.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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